PRIVATE AND CONFIDENTIAL

RESEARCH DEPARTMENT

The measured performance of typical German and American Band IV/V indoor aerials

REPORT No. E.091

1963/58

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

THE MEASURED PERFORMANCE OF TYPICAL GERMAN AND AMERICAN BAND IV/V INDOOR AERIALS

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SUMMARY

This report describes measurements made on three typical German and three typical American domestic indoor receiving aerials designed for television reception in Bands IV and V. The effective gain (relative to a half-wave dipole) and the horizontal radiation pattern of each aerial are given at 522 Mc/s, 666 Mc/s and 778 Mc/s.

1. DESCRIPTION OF THE AERIALS

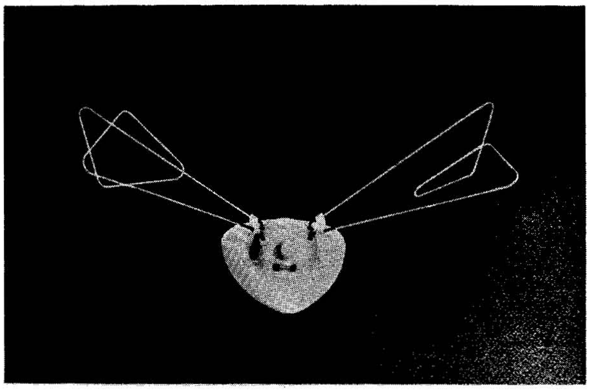
The aerials, shown in Fig. 1, were:

(a) Kathrein, model 4395 (b) Füba, model F.I.A. 1Q2 (c) Telefunken, 'Heimantenne'	made in Germany
(d) Hilo, model 303 (e) Hilo, model 202 (f) Tricraft, model 220	made in U.S.A.

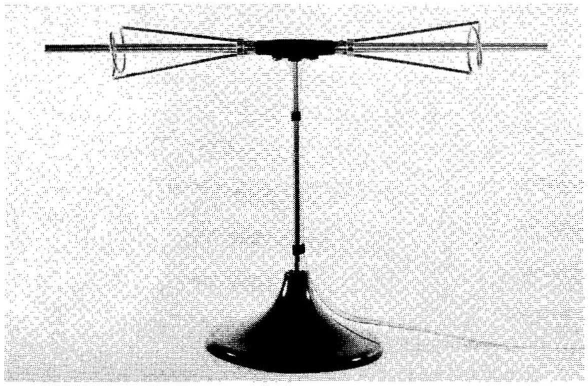
The Kathrein model (Fig. 1(a)) could be switched to either of two positions marked 'Band III' and 'Band IV/V'. Connexions to the switch are shown diagramatically in Fig. 2. In the Band III position the aerial is fed as a folded dipole; in Bands IV and V it approximates to a pair of end-fed half-wave dipoles. Throughout the tests, the switch was set to 'Band IV/V'.

It was not possible to dismantle the plastic base of the Füba aerial (Fig. 1(b)), its connexions could not therefore be investigated.

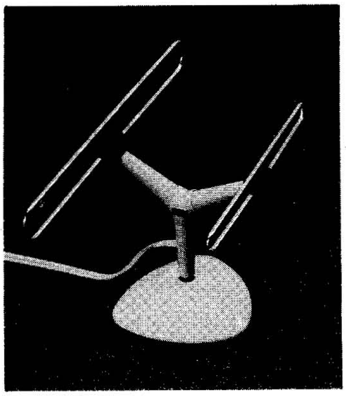
The Telefunken model (Fig. 1(c)) is a combined table lamp and a Band IV/V aerial. The aerial, comprising two horizontal bent 'bow tie' dipoles spaced 9½-inch



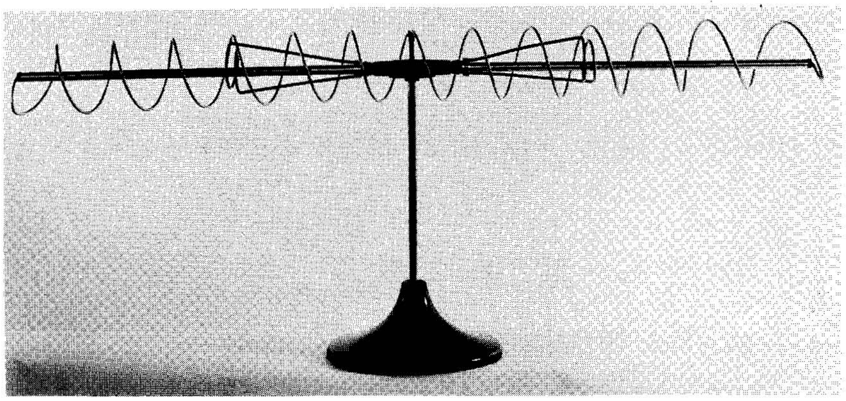
(*a*) *Kathrein, model 4395*



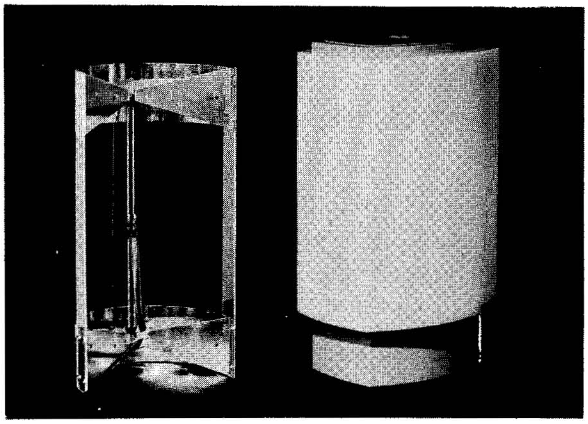
(*d*) *Hilo, model 303*



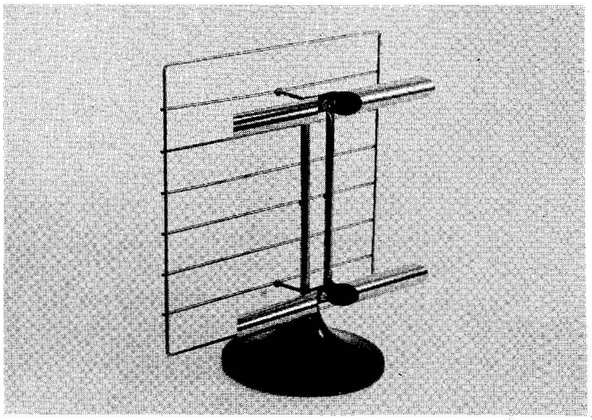
(*b*) *Füba, model F.I.A. 1Q2*



(*e*) *Hilo, model 202*



(*c*) *Telefunken, 'Heimantenne'*



(*f*) *Tricraft, model 220*

Fig. 1.

(24 cm) apart vertically, each backed by a metal strip, is shown on the left after removal of the plastic case which forms the lampshade; the bulb is situated roughly midway between the dipoles. The feeder is connected at the centre of a 250-ohm open-wire feeder joining the dipoles. During the tests, a loop of wire, simulating the metal parts of the bulb, was screwed in the lamp-holder. Moving the mains lead (when hanging vertically downwards more than 6-inch (15 cm) from the aerial feeder) made negligible change to the aerial performance.

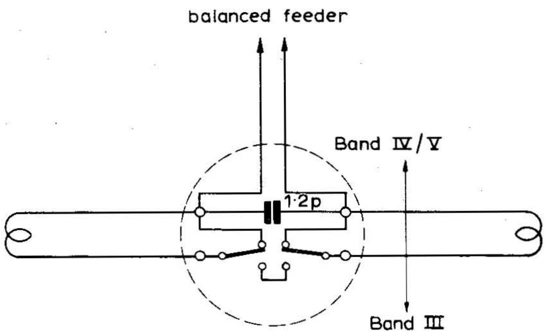


Fig. 2 - Switching connexions of Kathrein (Model 4395) aerial

The Hilo model 303 aerial (Fig. 1(d)), consists basically of a horizontal dipole 1·07λ long at 666 Mc/s. The Hilo model 202 (Fig. 1(e)) is similar, but the dipole (1·7λ long at 666 Mc/s) is enclosed within, and insulated from, a 12-turn helix.

The Tricraft aerial (Fig. 1(f)) comprises two dipoles each 0·62λ long at 666 Mc/s, mounted with 0·42λ vertical separation in front of a reflecting screen 0·68λ square. The feeder is connected at the centre of a 250-ohm open-wire feeder joining the dipoles.

All these aerials are of 'balanced' construction and were, with one exception, supplied with unscreened balanced feeder.

2. CONDITIONS OF TEST

Each aerial in turn was mounted on a wooden platform supported on an insulating pole about 5 ft (1·5 m) above ground. The balanced feeder extended downwards to a 'trombone' balun, cut to λ/2 at 666 Mc/s, supported about 1 ft (30 cm) above ground. Each aerial was tested using either the balanced feeder supplied, or a length of 300 ohm flat twin feeder (Telcon type K25B).

In every case, the feeders supplied with the aerials were longer than the direct 4 ft (1·2 m) run between the platform and the balun. In a typical domestic installation, the excess feeder would probably be coiled near the receiver, particularly in the case of those feeders which are fitted with a balanced plug for connexion to the receiver. It was found, however, that this arrangement can distort the radiation pattern of the aerial very considerably. The distortion may have been caused by imperfections in the balun at 522 Mc/s and 778 Mc/s, the two extreme test frequencies. Comparable distortion of the h.r.p. was, however, observed also at 666 Mc/s; it therefore seems likely that random coiling, causing an unbalance of the nominally-balanced feeder, was an important contributory factor. To standardize the test conditions, therefore, each feeder was cut to the length required for the test arrangement. The result of one comparative measurement, made on an aerial with a coiled feeder, is included in this report to show the order of magnitude of the effect. Results are also given which show the effect of connecting a simple balanced aerial by means of an unbalanced feeder.

Horizontal radiation patterns were measured by rotating the wooden platform. Gain measurements were made by substituting for each aerial, feeder and balun a calibrated half-wave dipole with an associated Pawsey stub. The measured gains apply to the ratio of the voltages across a 71-ohm terminating resistor, corrected for the feeder and mismatch loss associated with the half-wave dipole. The results therefore refer to the effective gains of the aerials, including the loss in the 4 ft (1·2 m) length of balanced feeder, the balun, and the mismatch loss between the terminating resistor and the input to the balun.

For the great majority of the stations envisaged in the United Kingdom the frequency allocations in Bands IV and V may be grouped as follows:

(a) Band IV, Channels 21 - 33, 470 Mc/s to 574 Mc/s, 19 stations

(b) Lower Band V, Channels 39 - 51, 614 Mc/s to 718 Mc/s, 16 stations

(c) Upper Band V, Channels 53 - 65, 726 Mc/s to 830 Mc/s, 17 stations.

Measurements were made at the centre frequency of each of these three groups, namely 522 Mc/s, 666 Mc/s and 778 Mc/s.

3. RESULTS

3.1. Horizontal Radiation Patterns

The horizontal radiation patterns of each of the six aerials at the three test frequencies, measured with balanced feeders, are shown in Figs. 3 and 4; the aerials are numbered according to the key given in Section 1. The patterns are scaled relative to the maximum signal strength that would be obtained from a half-wave dipole.

Fig. 5 shows the change to the pattern as the result of coiling a surplus of about 2 ft (60 cm) of the balanced feeder near ground level. Different coiled arrangements caused unpredictable changes in the pattern, and although the effect is shown only at 778 Mc/s, other coiled arrangements would probably have changed the pattern to a similar extent at all the measurement frequencies.

Figs. 6 and 7 show the effect on the horizontal radiation pattern due to connecting a balanced aerial by means of an unbalanced coaxial feeder; the change is due to a current which flows on the outer of the coaxial feeder and, in a push-push mode, in the two limbs of the dipole.[1] This current affects the radiation pattern in two ways:

(i) That flowing on the feeder causes extra radiation which may occur in any direction, depending on the disposition of the feeder.

(ii) That flowing into the two limbs of the dipole causes an additional component of radiation which is zero in line with the dipole or at right angles to it, but which is finite in other directions.

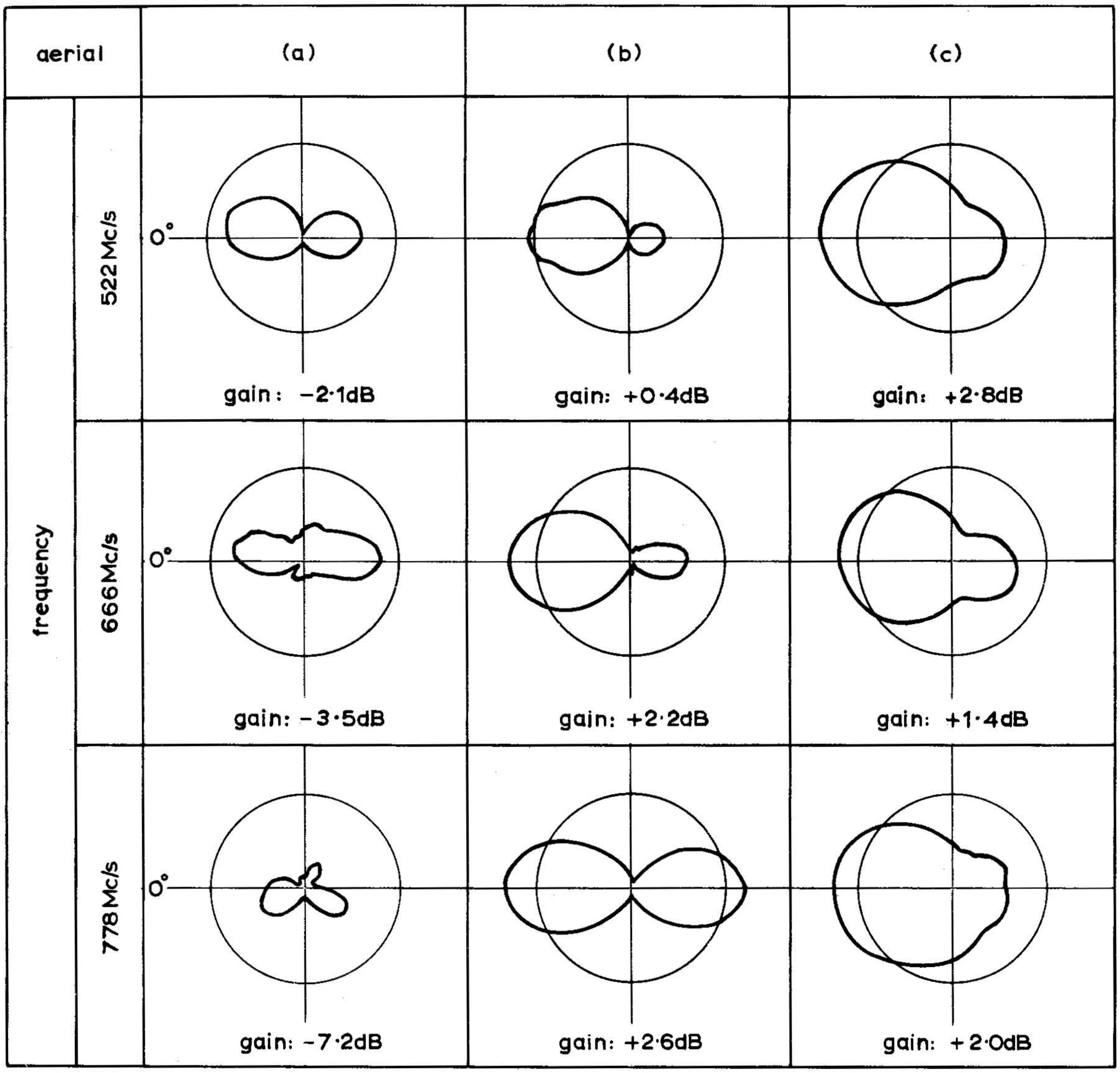


Fig. 3 - Horizontal radiation patterns and gains of the three German aerials

Each circle represents the maximum signal strength received from a half-wave dipole

Thus, as shown in Fig. 7, some distortion occurs even when the feeder is disposed normal to the plane of polarization. The degree of distortion is affected by the length of coaxial feeder, since the length influences the magnitude of the push-push current; the effect would, however, be less on a directional aerial than on the aerial used to obtain the results shown in Figs. 6 and 7.

3.2. Gain

As described in Section 2, the gain of each aerial was measured by substitution with a calibrated half-wave dipole. The gain was measured along the bearing normal to the aerial elements, corresponding to 0° of Figs. 3 and 4. Because of the horizontal radiation characteristics of the Hilo 202 aerial at this bearing (aerial (e) in Fig. 4), the accuracy of measurement for that aerial was about ± 0·4 dB. The results for the other aerials were obtained to an accuracy of about ± 0·2 dB.

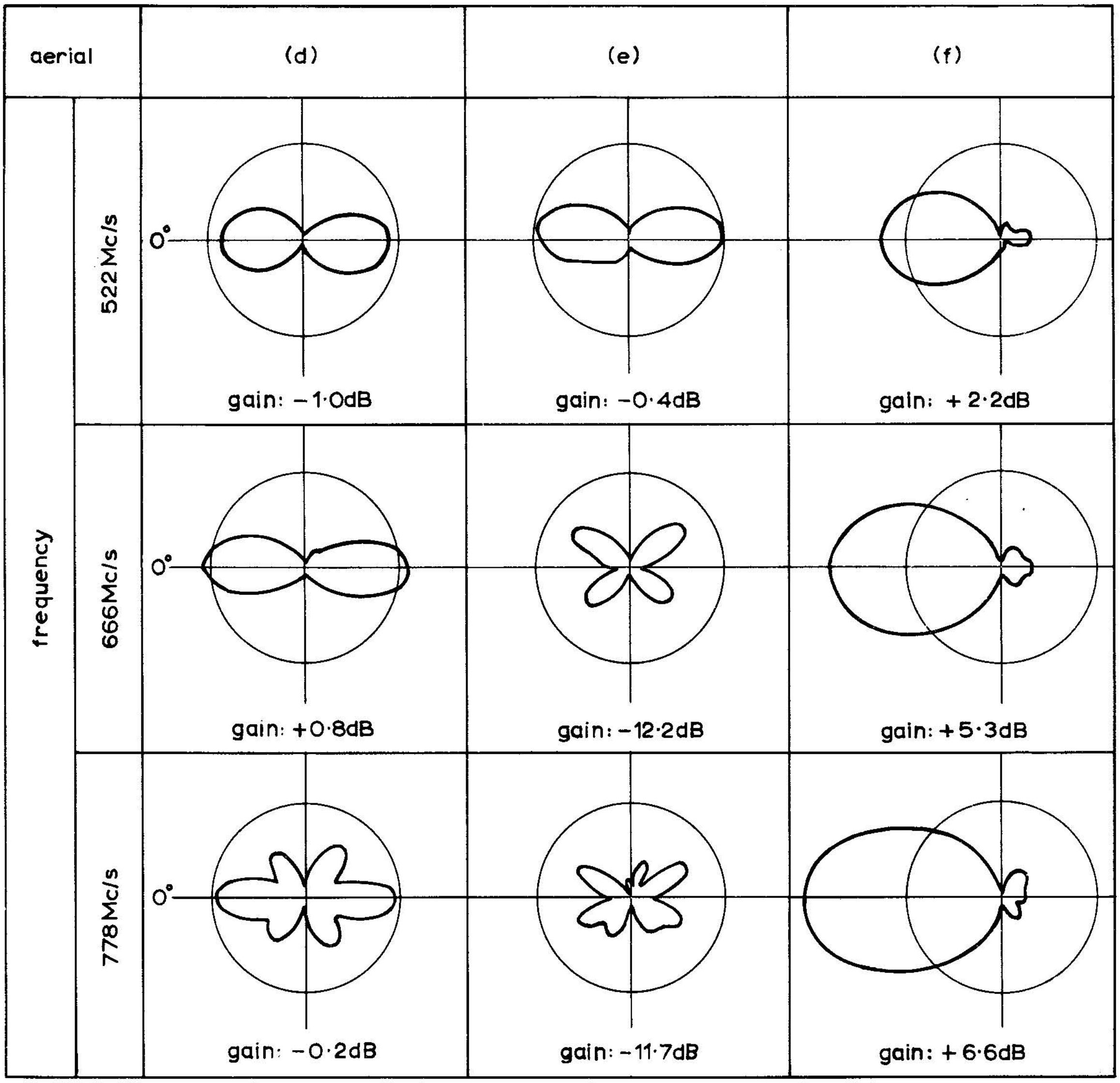


Fig. 4 - Horizontal radiation patterns and gains of the three American aerials

Each circle represents the maximum signal strength received from a half-wave dipole

The effective gain of each aerial, including the loss in the feeder and the balun, together with the mismatch loss when used with a 71-ohm resistive load, is shown in Figs. 3 and 4. The results have been used to draw to scale, on each diagram of Figs. 3 and 4, a circle with radius representing the maximum sensitivity of a half-wave dipole.

4. CONCLUSIONS

The usual requirements of a receiving aerial are that it should have adequate gain and be able to discriminate to a useful degree against reflected signals arriving from a direction other than that of the main signal. This is probably also true of

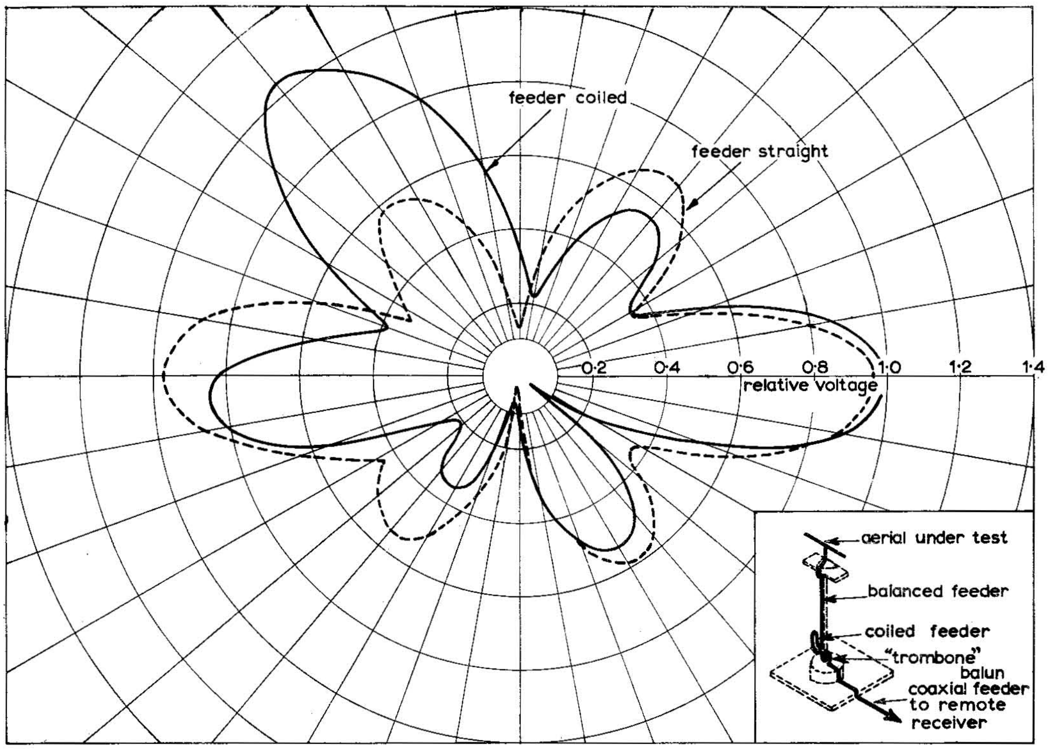


Fig. 5 - Effect of coiling the balanced feeder (as inset)
Hilo aerial (Model 303), 778 Mc/s

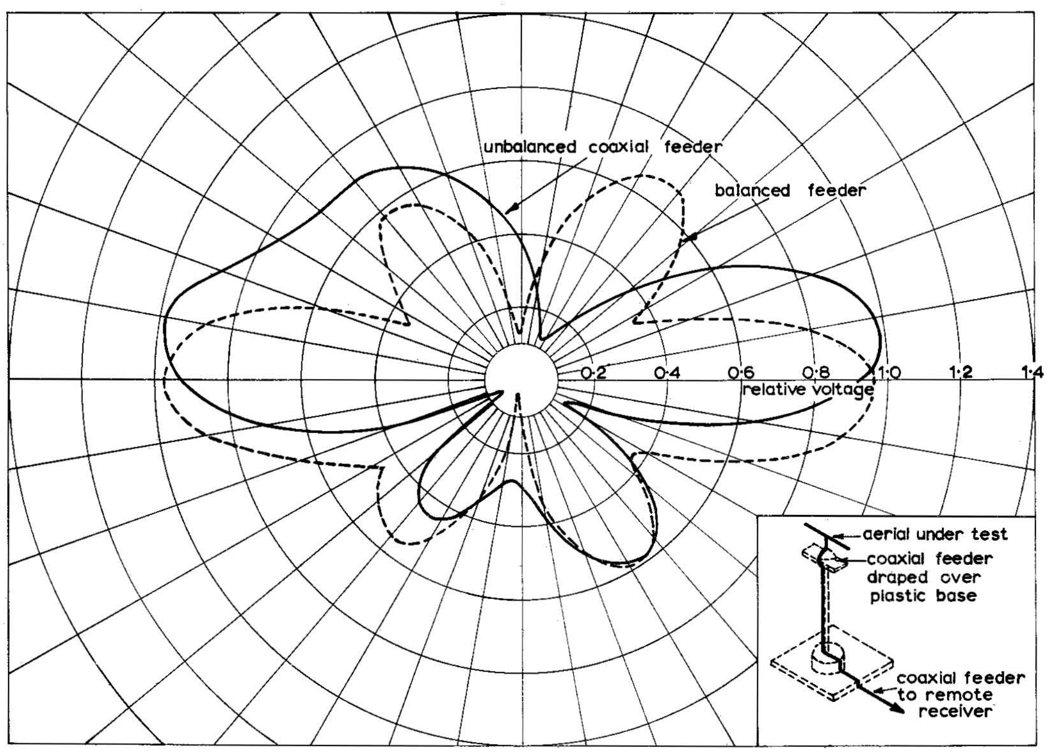


Fig. 6 - Effect of connecting the aerial by means of a coaxial cable draped over the plastic base plate (as inset)
Hilo aerial (Model 303), 778 Mc/s

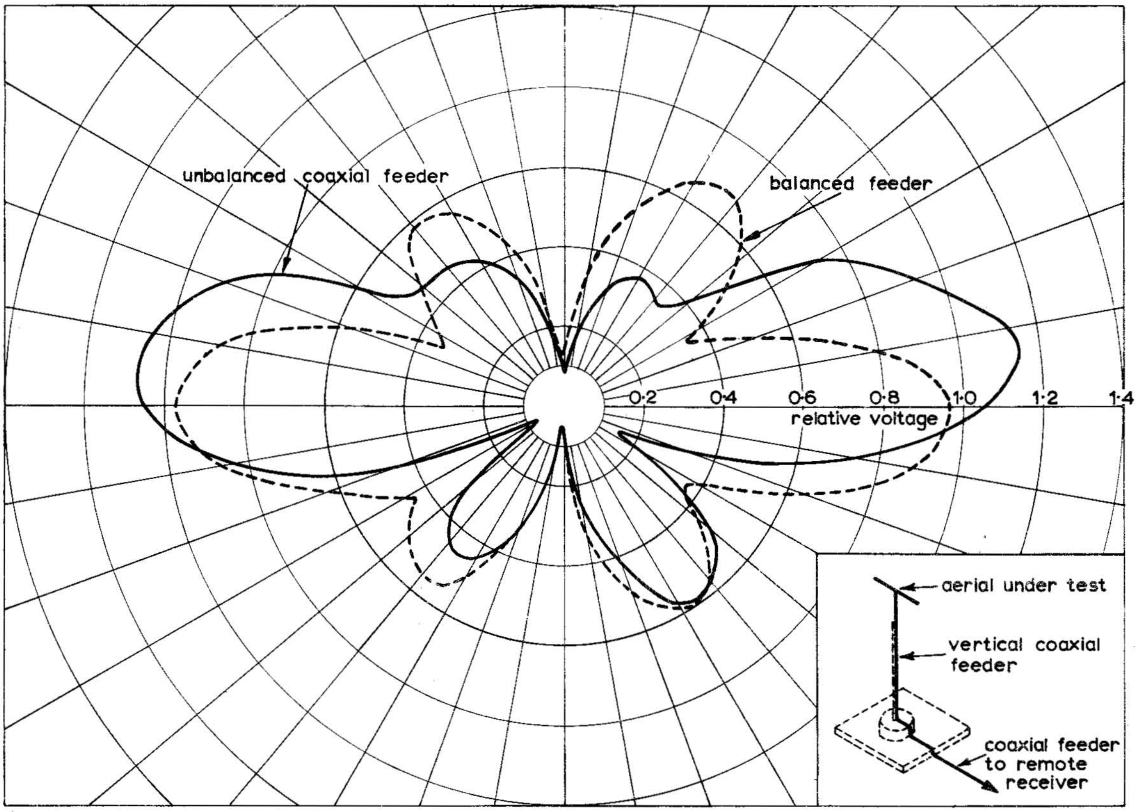


Fig. 7 - Effect of connecting the aerial by means of a coaxial cable extending vertically downwards (as inset)

Hilo aerial (Model 303), 778 Mc/s

an indoor aerial, since experience of u.h.f. reception in the home shows that some directivity is desirable to reduce the effect of reflexions within the building, including the variable reflexions from occupants of the room. Assuming that the viewer would be prepared to adjust the position and orientation of the aerial in the first place, but not when subsequently changing between programmes radiated from a common transmitting site, it seems preferable that an indoor u.h.f. aerial should be reasonably directional and have a single main lobe, the orientation of which stays the same over the operative frequency range. In these circumstances, the American Tricraft aerial would probably be the most satisfactory, due to its excellent directional characteristics and useful gain, both of these features being well maintained at the three frequencies employed in the tests.

It is also true that the use of an approximately omnidirectional aerial, which may be set in the room in a manner dictated solely by aesthetic considerations, is attractive but such an aerial is likely to be satisfactory only in a very small proportion of cases. The least directional aerial of those examined was the Telefunken model, but even in this case a single main lobe and a front-to-back ratio of about 6 dB was well maintained over the operative range of frequencies.

An important point, to which attention must be drawn, is the serious degradation of the radiation pattern which may occur with the use of a partly-coiled

length of twin feeder, or with the omission of a satisfactory 'balun' transformer in cases where a balanced aerial is used in conjunction with an unbalanced receiver input.

5. ACKNOWLEDGEMENT

The assistance of Mr. A. Jackson in carrying out the experimental work is gratefully acknowledged.

6. REFERENCE

Monteath, G.D. and Knight, P., 'The Performance of a Balanced Aerial when Connected Directly to a Coaxial Cable', Proc. I.E.E., Paper No. 3079 E, January 1960 (**107** B, p. 21).